Air Quality

Introduction

Air pollution is one of the major environmental challenges modern society faces. Human health effects can range from lung irritation to cancer and premature death, while ecological effects include damage to crops, forests, and rangeland, soil acidification, and contamination of water bodies. Air pollution consistently ranks high among public concerns in California, and control efforts have been given a high priority in recent decades. Sources of air pollution include automobiles, trucks, and other on- and off-road mobile sources; paints, consumer products, pesticides, and other widespread sources; and power plants, refineries, and other large "point sources." While technological advances and regulatory strategies have yielded significantly cleaner air over the past decades, increases in population and automobile use provide challenges to continued air quality improvements.

Air quality indicators reflect pressures on the environment (emissions), state of the environment (ambient concentrations), and potential health risk posed by air pollutants. This succinct set of indicators, considered collectively, is intended to provide an understanding of the state's air quality, sources of air pollution, and potential effects on the public. Indicators for ecological effects of air pollution and global climate change are addressed in other sections of this report.

Air Quality Indicators

Criteria Air Pollutants

Ozone

Days with unhealthy levels of ozone pollution (Type I)

Peak 1-hour ozone concentration (Type I)

Exposure to unhealthy ozone levels in the South Coast air basin (Type I)

Emissions of ozone precursors —Volatile organic compounds + Oxides of nitrogen (Type I)

Particulate matter (PM10)

Days with unhealthy levels of inhalable PM10 (Type I)

Peak 24-hour PM10 concentration (Type I)

Annual PM10 concentration (Type I)

Total primary and precursor PM10 emissions (Type II)

Carbon monoxide

Days with unhealthy levels of carbon monoxide (Type I)

Peak 8-hour carbon monoxide concentration (Type I)

Carbon monoxide emissions (Type I)

Toxic air contaminants (TACs)

Total emissions of TACs (Type II)

Community-based cancer risk from exposure to TACs (Type II)

Cumulative exposure to TACs that may pose chronic or acute health risks (Type II)

Visibility

Visibility on an average summer and winter day and in California national parks and wilderness areas (Type II)

Indoor air quality

Household exposure of children to environmental tobacco smoke (Type I)

Indoor exposure to formaldehyde (Type III)

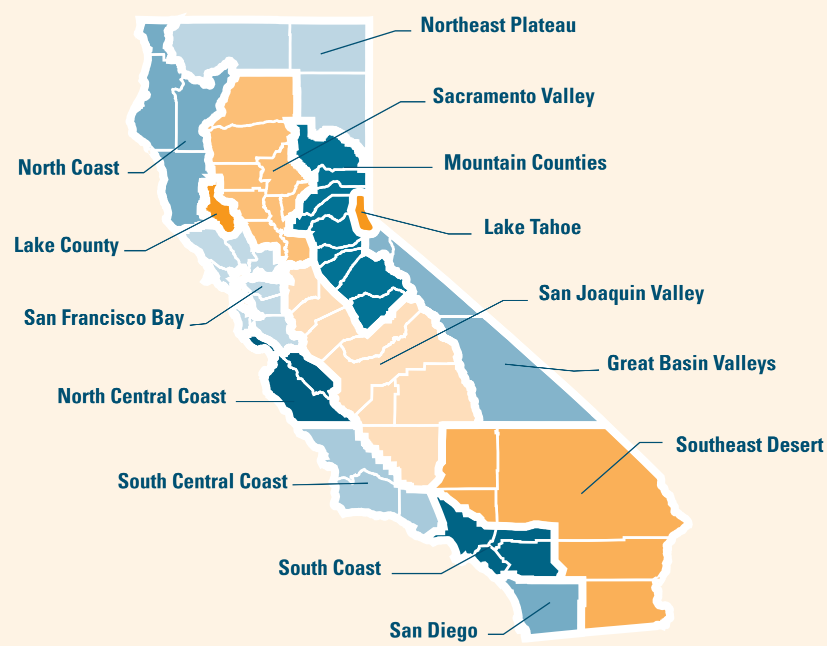
Issue 1: Criteria Air Pollution

Shortly after its creation in 1970, the U.S. Environmental Protection Agency (U.S. EPA) established health-based National Ambient Air Quality Standards (NAAQS) for six common "criteria" air pollutants. These standards cover carbon monoxide, ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead (Pb), and particulate matter (PM). California also sets its own ambient air quality standards that are generally more health-protective than NAAQS for most pollutants.

Indicators have been selected only for criteria pollutants for which one or more California air basins are in non-attainment of – that is, air concentrations of a criteria air pollutant are at levels equal to or exceeding — a state or federal air quality standard. The most health protective state or federal standard has generally been chosen as an indicator benchmark. For example, the number of days above the state 8-hour standard for carbon monoxide is generally more stringent than the state or federal 1-hour standard, because an area in attainment of the state 8-hour standard usually also attains the other state and federal carbon monoxide standards.

As a result of technological advances and implementation of control measures over the past three decades, emissions and ambient levels of criteria pollutants have declined steadily throughout most of the state. While all of California now attains the state and federal nitrogen dioxide, sulfur dioxide, and lead standards, most Californians still live in regions with unhealthy levels of ozone,

California Air Basins



particulate matter, or carbon monoxide. The California map on page 28 divides the state into the major air basins. The five main air basins that face the greatest challenge in controlling criteria air pollutants are the Sacramento Valley, San Joaquin Valley, San Francisco Bay Area, South Coast (including Los Angeles), and San Diego. These five air basins will be highlighted in most of the air quality indicator descriptions.

Ozone:

Ground-level ozone is a major component of urban and regional smog. Ozone is not directly emitted, but is formed when volatile organic compounds (VOCs) and oxides of nitrogen (NOx) emissions react in the presence of sunlight. Ozone is a strong irritant, which can reduce lung function and aggravate asthma as well as lung diseases such as bronchitis and emphysema. Repeated short-term ozone exposure may harm children's developing lungs and lead to reduced lung function in adulthood. In adults, ozone exposure may accelerate the natural decline in lung function that occurs as part of the normal aging process. While ozone levels have generally declined in recent decades, the state's major urban areas and the Central Valley still violate the state and federal ozone standards.

Indicators

Days with unhealthy levels of ozone pollution (Type I)

Peak 1-hour ozone concentration (Type I)

Exposure to unhealthy ozone levels in the South Coast air basin (Type I)

Emissions of ozone precursors (VOC + NOx) (Type I)

Inhalable Particulate Matter (PM10):

Particulate matter with an aerodynamic diameter of 10 microns or less (PM10) is a mixture of substances that includes elements such as carbon, lead, and nickel; compounds such as nitrates, organic compounds, and sulfates; and complex mixtures such as diesel exhaust and soil. Particulate matter may occur as solid particles or liquid droplets. Primary particles are emitted directly into the atmosphere, while secondary particles result from gases that are transformed into particles in the atmosphere.

When inhaled, particles can increase the number and severity of asthma attacks and cause or aggravate bronchitis and other lung diseases. Community health studies also link particle exposure to the premature death of people who already have heart and lung disease, especially the elderly. Airborne particles are a primary component of haze that obscures visibility in cities, rural communities, and scenic parks.

Air monitors, designed to sample PM10 concentrations, are concentrated in regions where exceedances are most likely to occur. If any one of those 154+ monitors records a 24-hour average concentration over the state standard (50 micrograms per cubic meter [$\mu g/m^3$]), then the air basin in which that monitor is located exceeds the PM10 standard for that day. While PM10 levels have declined in recent decades, the South Coast, Central Valley, Salton Sea, and Great Basin continue to violate the federal 24-hour standard (150 $\mu g/m^3$) while most of the state is in violation of the stricter state standard.

Indicators

Days with unhealthy levels of inhalable particulate matter (PM10) (Type I)

Peak 24-hour PM10 concentration (Type I)

Annual PM10 concentration (Type I)

Total primary and precursor PM10 emissions (Type II)

Indicators

Days with unhealthy levels of carbon monoxide (Type I)

Peak 8-hour carbon monoxide concentration (Type I)

Carbon monoxide emissions (Type I)

Carbon monoxide:

Carbon monoxide is an odorless, colorless gas that is formed when fuels are incompletely burned. Motor vehicles, especially those that are poorly maintained, are the primary sources of ambient carbon monoxide in populated areas. When inhaled, carbon monoxide molecules bond with hemoglobin molecules in the blood, preventing them from carrying oxygen throughout the body. Reduced oxygen-carrying capacity is especially hazardous for those with heart disease or limited lung function.

Air monitors designed to measure carbon monoxide concentrations are spread throughout California. These air monitors are located in places where carbon monoxide exceedances are most likely to occur. Carbon monoxide levels have generally declined in recent decades, and only Los Angeles and Calexico still violate the federal or state standard for carbon monoxide.

Indicators

Total emissions of toxic air contaminants (Type II)

Community-based cancer risk from exposure to TACs (Type II)

Cumulative exposure to toxic air contaminants that may pose chronic or acute health risks (Type II)

Issue 2: Toxic Air Contaminants (TACs)

Toxic air contaminants are air pollutants that may cause serious adverse human health or environmental effects. TACs may exist as particulate matter or in gaseous form, and include metals, gases adsorbed onto particles, and certain vapors from fuels and other sources. Examples of TACs include benzene, dioxins, 1-3 butadiene, and particulate emissions from diesel-fueled engines (diesel PM). TACs exhibit a wide range of ambient concentrations, toxicities, and exposure-response relationships. Depending on the TAC, exposure to these pollutants can result in cancer, poisoning, eye, nasal, and skin irritation, and/or rapid onset of sickness, such as nausea or difficulty in breathing. Other effects may include immunological, neurological, reproductive, developmental, and respiratory problems. About 88 percent of the overall estimated cancer risk from air toxics results from diesel PM (70 percent), benzene (10 percent) and 1,3 butadiene (8 percent) - all substances that are derived primarily from the emission or combustion of petroleum products. For more information on TACs, visit: www.arb.ca.gov/toxics/tac/tac.htm

Extensive research is needed to better understand the cumulative effects of multiple air toxics. This is of particular concern in urban areas where residents are exposed to emissions from multiple sources. The California Air Resources Board (ARB) has made it a priority to assess and reduce risk at the community level to ensure that all Californians, including children, the elderly, and environmental justice communities, can breathe clean, healthful air. For more information on ARB’s environmental justice efforts, visit: arbis.arb.ca.gov/ch/ej.htm

Issue 3: Visibility

The same particles and gases linked to serious health and environmental effects can also significantly affect visibility. The scattering and absorption of light by particles and gases in the atmosphere limit the distance we can see, and degrade visual clarity and contrast. Both primary emissions and secondary formation of particles contribute to visibility impairment. Primary particles, such as elemental carbon from diesel and wood combustion, or dust from natural sources, are emitted directly into the atmosphere. Secondary particles that are formed in the atmosphere from gaseous emissions include nitrates from NOx emissions, sulfates from SO_2 emissions, and organic carbon particles formed from condensed hydrocarbon emissions.

Indicators

Visibility on an average summer and winter day and in California national parks and wilderness areas (Type II)

Issue 4: Indoor Air Quality

Studies of human exposure to air pollutants indicate that indoor levels of many air pollutants may be two to five times (and occasionally more than 100 times) higher than outdoor levels. This is a concern since people — in particular infants, young children, and the elderly who are more susceptible to adverse effects from pollutants — spend, on average, 90 percent of their time indoors. Over the past several decades, exposure to indoor air pollutants is believed to have increased due to a variety of factors, including the increased use of synthetic building materials and furnishings; the increased use of personal care products, pesticides, and household cleaners; the construction of more tightly sealed buildings; and reduced ventilation rates to save energy.

Environmental tobacco smoke (ETS), also known as secondhand smoke, is a major concern in indoor environments. ETS is of particular concern for children, having been associated with increased occurrence of childhood asthma, lower respiratory tract infections, low birth weight, and sudden infant death syndrome. Various tobacco-related health programs have been introduced since the early 1990s to increase the awareness of ETS dangers in the home. In California, a yearly statewide survey is conducted by the Department of Health Services to make a qualitative assessment of ETS exposure in households with children.

Another major indoor air pollutant of concern is formaldehyde. A primary source of this volatile organic compound (VOC) is pressed wood products. Formaldehyde is an irritant to the eyes, nose, throat and lungs, and long-term exposure may cause cancer. An indoor air indicator for this VOC would help determine the effectiveness of programs currently being put in place by Cal/EPA to reduce formaldehyde from pressed wood products, and to identify if other actions need to be taken.

Indicators

Household exposure of children to environmental tobacco smoke (Type I)

Indoor exposure to formaldehyde (Type III)

ETS and formaldehyde are just two of many potentially hazardous substances that can be found in indoor air. Other indoor air pollutants include other VOCs (such as tetrachloroethylene, trichloroethylene, chloroform, benzene, styrene, p-dichorobenzene, etc.), carbon monoxide, nitrogen dioxide, radon, particulate matter, lead, mold spores, and sources of allergens such as dust mite droppings, cat and dog dander, and cockroaches. Clearly, a complete indicator system would need to cover all classes of indoor air pollutants, not just ETS and formaldehyde.

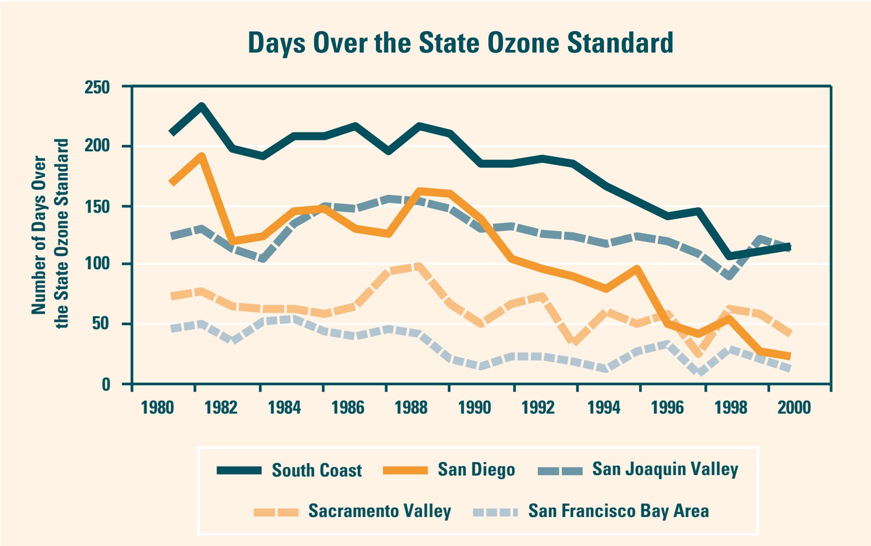
Currently, there are no programs in California that systematically collect quantitative data on people's exposures to indoor air pollutants in schools, public buildings, and homes. Ongoing monitoring data on indoor pollutants that are indicative of general indoor pollution levels could go far in improving our understanding of the scope and extent of the problem. This would facilitate identification of effective measures to reduce and prevent indoor pollution by tracking pollution levels before and after the implementation of preventative measures.

Days with Unhealthy Levels of Ozone

The number of days over the state 1-hour standard vary by region and are declining in most of California.

Type I

Level 4
Goal 1



What is the indicator showing?

The number of days in California with unhealthy levels of ozone has decreased substantially over the past two decades. Decreases were modest during the 1980s but accelerated during the 1990s.

Why is the indicator important?

This indicator tracks the number of days in which each California air basin exceeds the state 1-hour ozone standard of 0.09 parts per million (ppm), and illustrates the chronic nature of the public's exposure to ozone. Scientific studies suggest that exposure above this level may impair breathing and aggravate asthma and lung diseases such as bronchitis and emphysema. Intermittent exposure to high levels of ozone may harm children's developing lungs and lead to reduced lung function in adulthood. In adults, ozone exposure may accelerate the natural decline in lung function that occurs as part of the normal aging process.

Attainment of ozone standards requires that ozone concentrations rarely exceed a threshold level that can cause harmful effects. For example, when on average only one day per year is above California's 1-hour ozone standard, the state standard will be attained. The vast majority of California (with the exception of some northern counties and undesignated rural areas) does not attain this state standard.

What factors influence this indicator?

Ozone levels depend upon emissions of ozone precursors [volatile organic compounds (VOCs) and oxides of nitrogen (NOx)] and weather. VOCs and NOx are emitted by a wide range of sources, including: automobiles, trucks, and other on- and off-road mobile sources, paints, solvents, pesticides, and other widespread sources; and power plants, refineries, and other large "point sources." Reductions from most sources have occurred due to technological improvements. Tighter emission standards for new motor vehicles, for example, provide significant reductions as older, dirtier vehicles are retired.

While efforts to reduce precursor emissions have proven effective in reducing the number of unhealthy ozone days, particularly in the 1990s, weather plays a greater role than precursor reductions on a year-to-year basis. For example, a hot summer day with stagnant air conditions will greatly increase the chance of unhealthy ozone levels. This indicator is also influenced by the number and location of air quality monitors (see below).

Technical Considerations:

Data Characteristics

Data needed to determine the number of days with unhealthy levels of ozone is readily available from existing networks of air quality monitors in California. More than 200 ozone monitors have been placed in California, primarily in urban areas, to measure ozone concentrations hourly throughout the year or during the summer ozone season. The measurement methods are standard (ultraviolet absorption) and highly precise. Locations for most ozone monitors are selected to secure representative data on an "urban" scale (4 to 50 kilometers). The data are maintained on the Aerometric Data Analysis and Management (ADAM) System. These data satisfy rigorous criteria for quality assurance.

Strengths and Limitations of the Data

The number of days with unhealthy levels of ozone represents the chronic nature of unhealthy ozone levels in a region. This indicator can be used to approximate a region's status with respect to the 1-hour ozone standard. It can also be used to construct trends that may respond differently over time compared to other ozone indicators.

While the data indicate the number of times an area exceeds the state health-based ozone standard, it does not capture multiple exceedances in the same day, or the degree of each exceedance. In addition, although most air basins exceeding ozone standards have multiple monitoring stations, there is no mechanism for recording exceedances in non-monitored areas. Strategic monitor placement, however, allows for capturing of air quality measurements representative of an area since ozone is a regional pollutant and generally does not vary significantly over short distances. As emissions of VOCs and NOx decrease, this indicator should respond with reduced counts of days with unhealthy ozone.

Using readily available air quality data, this indicator can be reproduced easily.

References:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

For more information, contact:

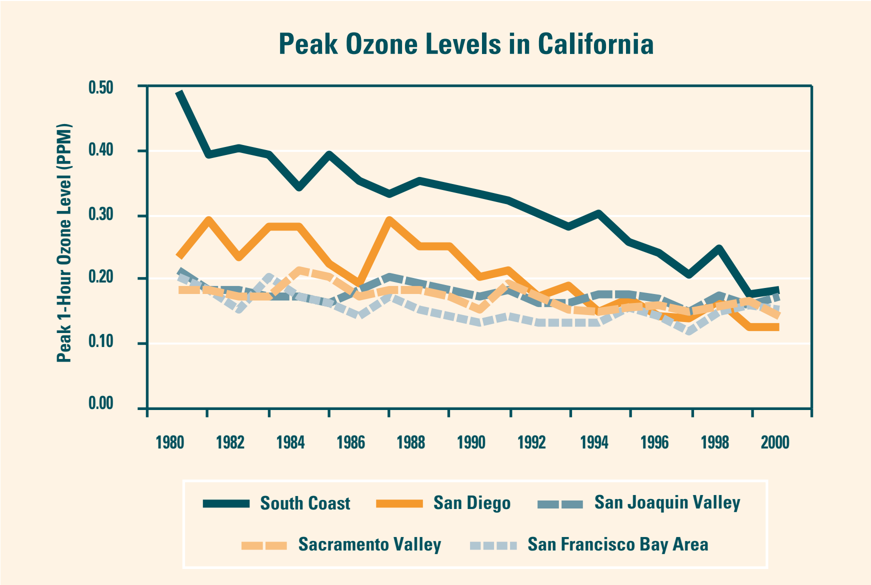
Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

Peak 1-Hour Ozone Concentration

The highest 1-hour ozone concentration measured at most monitors in the state has declined.

Type I

Level 4
Goal 1



What is the indicator showing?

Peak ozone levels have been declining fastest in the air basins with the greatest air quality problems, including the South Coast (Los Angeles Basin) and San Diego air basins.

Why is the indicator important?

This indicator is the highest measured 1-hour concentration at any monitor within an air basin for a particular year. Thus, the indicator represents the "worst-case" for a 1-hour exposure to ozone in a specified region, and provides a view of the potential for acute adverse health impacts due to ozone exposure. The peak 1-hour ozone concentration has declined substantially in some major urban areas in California over the last 20 years. In the South Coast Air Basin, the peak 1-hour ozone concentration decreased more than 40 percent, from an average of 0.41 ppm in 1980-82, to 0.22 ppm in 1997-99.

What factors influence this indicator?

Ozone levels depend upon emissions of ozone precursors volatile organic compounds (VOCs) and nitrogen oxides (NOx) and weather. While efforts to reduce precursor emissions have proven effective in reducing peak ozone concentration, weather also impacts the efficiency with which VOCs and NOx produce ozone and the extent to which ozone is concentrated in or removed from an area. A hot, sunny day with stagnant air conditions will generally result in higher peak levels of ozone. This indicator is also influenced by the number and location of air quality monitors (see below).

Technical Considerations:

Data Characteristics

The peak 1-hour ozone concentration represents the "worst-case" for 1-hour exposures to ozone in a region. This indicator can be used to approximate a region's status with respect to a 1-hour ozone standard. It can also be used to construct trends for peak ozone concentrations that respond to changes in the emissions of VOCs and NOx. Using readily available air quality data, this indicator can be reproduced easily.

Strengths and Limitations of the Data

Data needed to determine the peak 1-hour ozone concentration are readily available from existing networks of air quality monitors in California. More than 200 ozone monitors in California measure ozone concentrations hourly throughout the year or during the high ozone season when the annual maximum occurs. The measurement methods are standard (ultraviolet absorption) and highly precise. Locations for most ozone monitors are selected to secure representative data on an "urban" scale (4 to 50 kilometers). The data are maintained on the Aerometric Data Analysis and Management (ADAM) System. These data satisfy rigorous criteria for quality assurance. This indicator can be easily scaled to represent a single monitoring location or to represent a regional or statewide maximum.

While the data indicate the highest measured ozone concentration in each basin, they do not capture the number of times people were exposed to unhealthy air, the number and extent of additional high ozone levels, or the damage inflicted on the people of California. In addition, although most air basins exceeding ozone standards have multiple monitoring stations, there is no mechanism for recording high ozone levels that may occur in non-monitored areas. Strategic monitor placement allows for capturing of air quality measurements representative of the area, however, since ozone is a regional pollutant and generally does not vary significantly over short distances.

References:

Statewide Ozone Data Summary (1980-1998). Posted at: www.arb.ca.gov/aqd/ozone/stateoz1.htm

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

For more information, contact:

Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

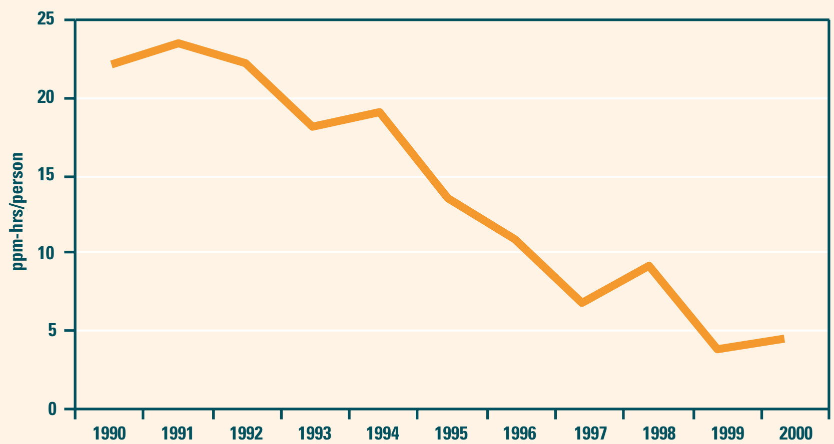
Exposure to Unhealthy Ozone Levels in the South Coast Air Basin

Since 1990, the total annual exposure to unhealthy ozone levels for the average person has dramatically declined.

Type I

Level 4
Goal 1

Total Annual Exposure to Unhealthy Levels of Ozone for the Average Person in the South Coast Air Basin



What is the indicator showing?

Exposure to unhealthy levels of ozone – based on duration of exposure and level of ozone pollution – has declined for the average resident in and around Los Angeles.

Why is this indicator important?

There are a number of ways to look at how ozone levels in California have changed over the years. Although simple indicators (such as those based on peak 1-hour levels or the number of days above the standard) are most commonly used, complex indicators that incorporate multiple parameters can offer additional insight concerning air quality. This is one such indicator. It reflects total annual (population-weighted) exposures to ozone. An "exposure" occurs when ozone concentrations exceed the 1-hour ozone standard, 0.09 parts per million (ppm). The indicator presents a composite of exposure at individual locations that have been weighted or adjusted to emphasize equally the exposure of each individual in an area. Both the magnitude and the duration of the average level of exposure to concentrations greater than the standard are incorporated into the indicator (ARB, 2001). For example, someone exposed to 0.15 ppm ozone (0.06 ppm above the state standard) for 220 hours would have an exposure level of 13.2 ppm-hrs (220 hrs x 0.06 ppm = 13.2 ppm-hrs). Ozone monitors located throughout the South Coast air basin, combined with air modeling techniques and census tract data, provide the data for determining the exposed population. In most years between 1990 and 2000, all residents of the South Coast air basin were exposed to ozone levels above the standard at some time during each year.

Some major urban areas in California have not seen the peak 1 hour ozone concentration decrease significantly over the last 20 years. Although attainment is based on peak concentrations (which provide an indication of the potential for acute adverse health impacts), total annual exposure provides an indication of the potential for chronic adverse health impacts. At this time, the South Coast is the only air basin in California for which total annual ozone exposure data have been developed. All five major air basins, including the South Coast, San Joaquin Valley, Sacramento Valley, San Francisco Bay Area, and San Diego air basins, will be included in this indicator in future updates.

What factors influence this indicator?

This indicator is dependent upon amount of time and the severity of unhealthy ozone pollution to which people are exposed. This is related to emissions of ozone precursors, as well as temperature and other weather considerations.

Technical Considerations:

Data Characteristics

The indicator is calculated using hourly ozone measurements that are above the level of the state standard. For each hour in the year, the concentration at the center of each census tract is estimated by interpolating the ozone concentrations at nearby monitors. Only monitors within a 50 kilometer radius of a census tract are included in the interpolation. Then, the increment between the estimated concentration and the state standard is computed (when the estimated concentration is lower than the state standard, the increment is set to zero). These increments are then weighted by population in each census tract and summed. The sum is divided by the total exposed population for that hour to obtain a population-weighted average. Finally, the hourly averages are summed for the year. Zero exposure areas (populated areas that had no exceedances for a given year) are not included in the exposure calculations because they dilute the real impact of the ozone concentrations that are above the state standard.

Strengths and Limitations of the Data

Air quality data needed for this indicator are readily available from existing networks of air quality monitors in California. More than 200 monitors in California measure ozone concentrations hourly throughout the year, or during the high ozone season when the exceedances of the standard occur. Population data (by census tract) from the 1990 U.S. Census are used. Updates for this indicator will apply more current census data.

Individuals are presumed to have been exposed to the concentrations measured by the ambient air quality monitoring network. However, daily activity patterns (for example, being inside a building or exercising outdoors) may diminish or increase actual exposures.

References:

California Air Resources Board. The 2001 California Almanac of Emissions and Air Quality. Posted at: www.arb.ca.gov/aqd/almanac01/almanac01.htm

Statewide Ozone Data Summary (1980-1998). Posted at: www.arb.ca.gov/aqd/ozone/stateoz1.htm

For more information, contact:

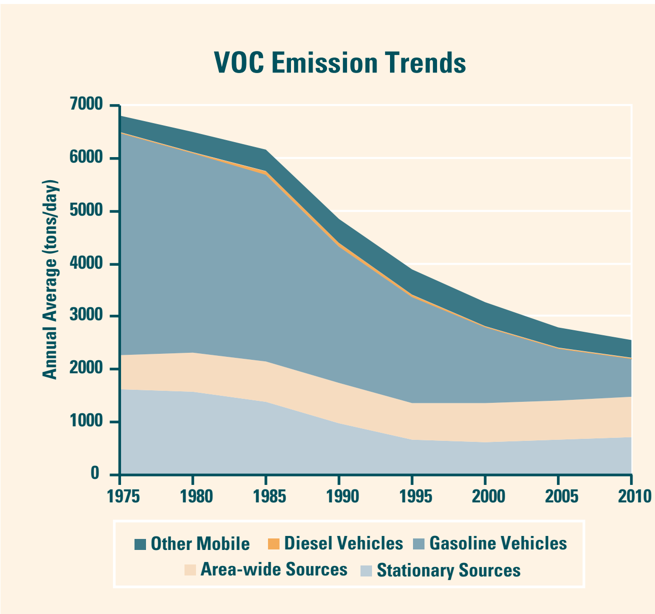
Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

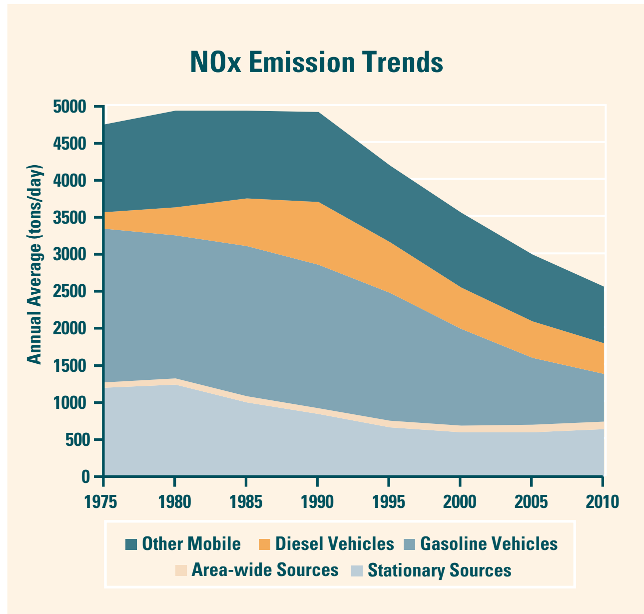
Emissions of Ozone Precursors – Volatile Organic Compounds (VOC) + Oxides of Nitrogen (NOx)

Statewide emissions have been declining.

Type I

Level 3
Goal 1





Why is the indicator important?

Volatile organic compounds (VOCs) and nitrogen oxides (NOx) react to form ozone in the atmosphere in the presence of sunlight. Emissions of these ozone precursors thus serve as an indicator of the ozone-forming potential in an area. VOC and NOx emissions are estimated as tons of emissions per day, averaged over an entire year.

What is the indicator showing?

Total emissions of both pollutants have been declining over the past 25 years. The greatest declines have resulted from reduction of gasoline vehicle emissions.

What factors influence this indicator?

Emissions come from four types of sources: stationary sources (including factories, power plants, and refineries), area-wide sources (including residential wood combustion, wildfires, and emissions from architectural coatings), mobile sources (including on- and off-road vehicles), and natural sources.

VOC emissions in California are projected to decrease by over 60 percent between 1975 and 2010, largely as a result of the state's on-road motor vehicle emission control program. This includes the use of improved evaporative emission control systems and computerized fuel injection and engine management systems to meet increasingly stringent California emission standards, cleaner gasoline, and the Smog Check program. VOC emissions from other mobile sources are projected to decline between 1995 and 2010 as more stringent emission standards are adopted and implemented. VOC emissions from diesel vehicles are very small relative to other sources of VOCs. Hence, the contribution from this source cannot be easily discerned in the VOC emissions trends graph. Substantial reductions have also been obtained for area-wide sources through the vapor recovery program for service stations, bulk plants and other fuel distribution operations. There are also on-going programs to reduce overall solvent VOC emissions from coatings, consumer products, cleaning and degreasing solvents, and other substances used within California.

NOx emission standards for on-road motor vehicles were introduced in 1971 and followed in later years by the implementation of more stringent standards and the introduction of three-way catalysts. NOx emissions from on-road motor vehicles have declined by over 30 percent from 1990 to 2000, and are projected to decrease by an additional 40 percent between 2000 and 2010. This has occurred as vehicles meeting more stringent emission standards enter the fleet, and all vehicles use cleaner burning gasoline and diesel fuel or alternative fuels. Stationary source NOx emissions dropped by over 40 percent between 1980 and 1995. This decrease has been largely due to a switch from fuel oil to natural gas and the implementation of combustion controls such as low-NOx burners for boilers and catalytic converters for both external and internal combustion stationary sources.

The decline in motor vehicle emissions has occurred in spite of the increase in vehicle miles traveled and increased fuel consumption in the state (see the transportation indicator in the background indicator section for more information).

Technical Considerations:

Data Characteristics

The relationship between VOC and NOx emissions and ozone formation is well known, and no other emissions indicator can more accurately reflect ozone forming potential. VOC and NOx emissions are most useful as indicators of multi-year trends in emissions. Emissions in past and future years are generated with the California Emission Forecasting System model, which uses the current year inventory as its input. This indicator is also useful in detecting regional differences in emission sources and patterns when emissions from various air basins are analyzed together.

Emissions from area-wide and natural sources are estimated using engineering methods on a rotating three-year basis; area-wide sources are adjusted with forecasting models in intervening years. Emissions from mobile sources are estimated with computer models yearly. Emissions from stationary sources are reported by air pollution control districts to the Air Resources Board on a yearly basis.

Strengths and Limitations of the Data

Local and regional air pollution control districts report emissions data for stationary sources to the Air Resources Board. Although some districts update their data yearly, others have not updated their emissions data for many years. Many area-wide source estimation methodologies are based on old data and are adjusted yearly with the use of surrogates. Total emissions of VOCs and NOx are estimated, not measured, using computer models.

VOC and NOx emissions data are heavily dependant on methodologies and models that may change from year to year. Because improvements in estimation methodologies or development of methodologies for previously uninventoried sources may result in misleading changes in emission levels between years, emissions are backcasted or forecasted based on growth and control data so that the inventory reflects consistent methodologies across trend years.

The photochemical relationship between VOCs and NOx is very complex, and occasionally increases in one pollutant can result in decreases in ozone formation. VOC and NOx emissions are not an exact predictor of actual ozone levels because ozone concentration is dependent on many other independent factors, including the ratio of VOCs to NOx, meteorology, climate, topography, and time of year. However, VOC and NOx emissions are excellent indicators of ozone forming potential, especially when combined with knowledge of other factors.

References:

California Air Resources Board. The 2001 California Almanac of Emissions and Air Quality. Posted at: www.arb.ca.gov/aqd/almanac01/almanac01.htm

California Air Resources Board. *Emission Inventory Procedural Manual, Volumes I-V*. 1997.

California Air Resources Board, Emission Inventory Web Page, Posted at: www.arb.ca.gov/emisinv/eib.htm

For more information, contact:

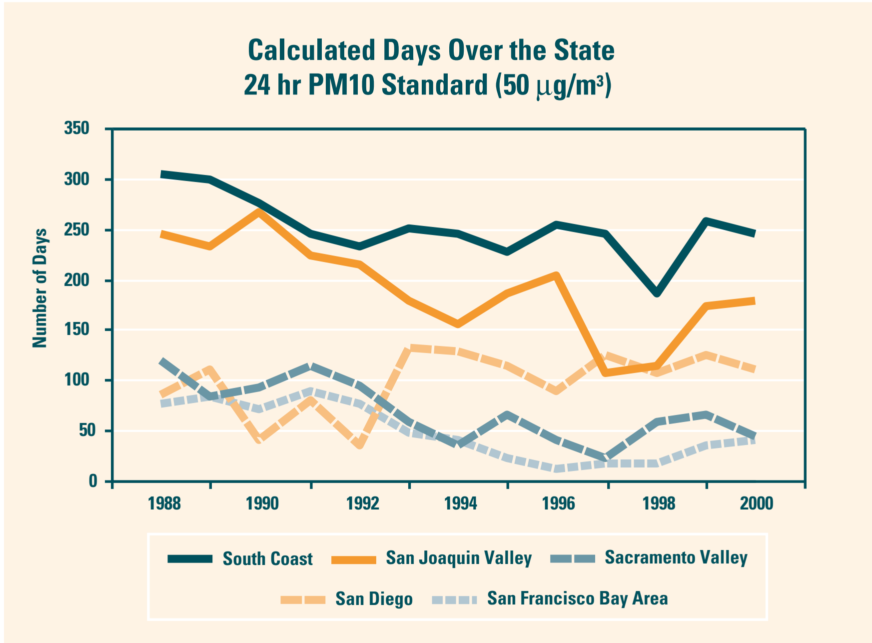
Andy Alexis
Planning and Technical Support Division
Air Resources Board
1001 I Street
Sacramento, California 95812
(916) 323-1085
aalexis@arb.ca.gov

Type I

Level 4
Goal 1

Days with Unhealthy Levels of Inhalable Particulate Matter (PM10)

Exposure to PM has declined or remained stable in most regions of the state.



What is the indicator showing?

Most of the major air basins have shown a moderate decline in number of days over the PM10 standard.

Why is the indicator important?

PM10 particles deposit deeply in the lungs and may contain substances that are particularly harmful to human health. Particle deposition in the lung is highly dependent on particle diameter, as smaller particles deposit deeper than larger particles. When inhaled, particles can increase the number and severity of asthma attacks and cause or aggravate bronchitis and other lung diseases. Community health studies also link particle exposure to the premature death of people with heart and lung disease, especially the elderly.

The number of days with unhealthy levels of inhalable particulate matter (over the state 24 hr standard of 50 micrograms per cubic meter ($\mu g/m^3$) describes the chronic extent of PM10 pollution. Despite the increase in population in urban areas and subsequent increase in vehicle miles traveled, PM10 levels are decreasing within most regions of the state.

What factors influence this indicator?

Exceedances of PM10 standards are influenced by emissions of directly-emitted particles and gases that form secondary particles in the atmosphere. These gases include reactive organic gases (ROG), ammonia, oxides of sulfur (SOx), and oxides of nitrogen (NOx). This indicator is also dependent on weather — secondary particles are more easily formed in the atmosphere during colder winter conditions, while fugitive dust levels are more likely to be higher on dry, windy days.

As more particulate monitors were deployed statewide throughout the 1990s, there was a greater potential to record exceedances in previously unmonitored regions. For example, three PM monitors deployed in San Diego in 1993 (including one at the Otay Mesa border region) contributed to that region's increase in days over the standard.

Technical Considerations:

Data Characteristics

Data needed to determine the days with unhealthy levels of PM10 are readily available from existing networks of air quality monitors in California. The data are maintained on the Aerometric Data Analysis and Management (ADAM) System and on the Federal Aerometric Information Retrieval System (FAIRS) data system. These data represent the highest quality assured PM10 data. The data are amenable to further analysis and processing with common spreadsheet and database software.

Particulate matter is only measured every sixth day. The number of days which exceed the standard are extrapolated from this data.

Strengths and Limitations of the Data

Extensive monitoring using accepted scientific instrumentation is performed in regions where PM10 standards are likely to be exceeded. As PM monitors are added or moved, the number and location of measurements change. On its own, the indicator does not provide information on population exposure. The indicator is also very sensitive to meteorological influences (i.e., windy or rainy days). The indicator is simple, with readily available data, and easy to apply.

Reference:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

For more information, contact:

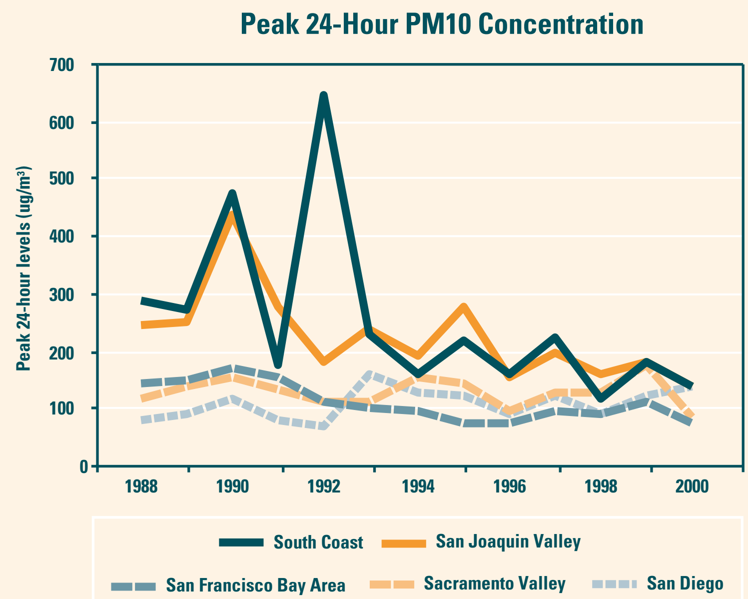
Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

Type I

Level 4
Goal 1

Peak 24-Hour Inhalable Particulate Matter (PM10) Concentration

Exposure to high PM10 levels have declined or remained stable since the mid-1990s.



What is the indicator showing?
Most of the major air basins have shown a moderate decline in maximum 24-hour PM10 concentrations.

Why is the indicator important?

The annual peak 24-hour PM10 concentration represents the "worst-case" for 24-hour exposures to PM10 in a region. When inhaled, particles can increase the number and severity of asthma attacks and cause or aggravate bronchitis and other lung diseases. Community health studies also link particle exposure to the premature death of people with heart and lung disease, especially the elderly.

What factors influence this indicator?

Particulate matter is only measured every sixth day. As more particulate monitors were deployed statewide throughout the 1990s, more measurements in some cases resulted in higher measured peaks. For example, San Diego added a PM monitor at the Otay Mesa border region in 1993. The new Otay Mesa monitor has recorded the San Diego basin's maximum PM10 levels each year since then. PM10 levels are more likely to be higher on dry, windy days, and lower on rainy days. A combination of drought years and high wind events are likely to have contributed to the spikes in PM10 levels in the South Coast and San Joaquin Valley Air Basins in 1990, and in the South Coast Air Basin in 1992.

Technical Considerations:

Data Characteristics

Data needed to determine the annual peak 24-hour PM10 concentration are readily available from existing networks of air quality monitors in California. The data are maintained on the Aerometric Data Analysis and Management (ADAM) System and on the Federal Aerometric Information Retrieval System (FAIRS) data system. These data represent the highest quality assured PM10 data. The data are amenable to further analysis and processing with common spreadsheet and database software. The 2001 Almanac is another useful source of annual average PM10 concentration data.

Strengths and Limitations of the Data:

While the indicator is simple, with readily available data, and easy to apply, it does not describe the number of monitors over the standard on a given day or provide population exposure information. The indicator is also very sensitive to meteorological influences.

References:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

California Air Resources Board. The 2001 California Almanac of Emissions and Air Quality. Posted at: www.arb.ca.gov/aqd/almanac01/almanac01.htm

For more information, contact:

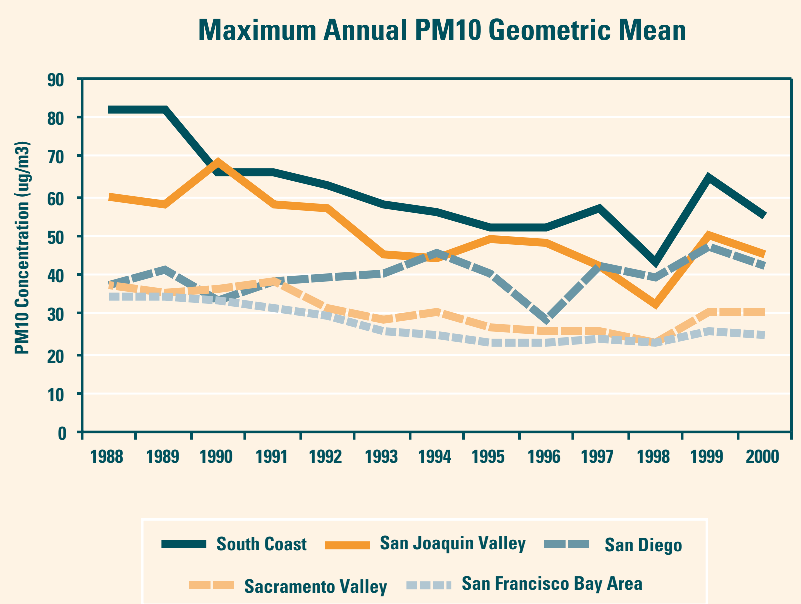
Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

Type I

Level 4
Goal 1

Annual Inhalable Particulate Matter (PM10) Concentration

Long-term exposure to PM10 levels have declined or remained unchanged.



What is the indicator showing?
Most air basins show moderate declines in annual PM10 levels.

Why is this indicator important?

Studies suggest that long-term exposure to inhalable particulate matter can contribute to breathing disorders, reduce lung function, and curtail lung growth in children. The indicator takes into account PM10 levels (collected every sixth day) during all seasons over a year, and provides a measurement for long-term exposure. California's maximum annual geometric mean PM10 standard (similar to maximum average annual PM10 concentration) is 30 micrograms per cubic meter ($\mu g/m^3$); the state standard will be attained when the maximum annual PM10 geometric mean is below this level. Most of the state's major urban areas and the Central Valley exceed the state standard.

What factors influence this indicator?

This indicator represents the highest annual mean PM10 concentration at any monitor within each air basin. In other words, the annual mean PM10 concentration was calculated for each monitoring site in an air basin and the highest mean among all of the sites is utilized.

As more particulate monitors were deployed statewide throughout the 1990s, more measurements in some cases resulted in higher annual mean concentrations. For example, the annual mean PM10 concentration in San Diego has been influenced by the addition of a new PM10 monitor at the Otay Mesa border in 1993.

The indicator by itself presents only limited information on ambient levels of PM10 in the state.

The suite of indicators for PM10 shows that despite the increase in population and vehicle miles traveled, PM10 levels are decreasing within most regions of the state. As California's population continues to grow, however, it will be increasingly difficult to sustain the emission reductions achieved thus far, particularly in the fastest growing parts of the state.

Technical Considerations:

Data Characteristics

The maximum annual PM10 geometric mean is similar to the average annual PM10 concentration, but is calculated by multiplying the highest 24-hour average PM10 concentration recorded every sixth day (particulate matter is only measured every sixth day) for a year, and then taking the nth root of that number. The methodology used to develop the maximum annual geometric mean indicator meets all of the primary criteria, and extensive monitoring using accepted scientific instrumentation is performed in regions where levels of PM10 may be expected to be exceeded. The indicator is a common method of presenting PM10 exceedances in other states and the information gathered is cost-effective.

The maximum annual geometric mean PM10 concentration represents the "worst-case" for annual average exposures to PM10 in a region. This indicator can be used to approximate a region's status with respect to an annual PM10 standard. It can also be used to construct trends for maximum annual average PM10 concentrations that respond to changes in the primary and secondary emissions of PM10.

Data needed to determine the annual average PM10 concentration are readily available from existing networks of air quality monitors in California. The data are maintained on the Aerometric Data Analysis and Management (ADAM) System and on the Federal Aerometric Information Retrieval System (AIRS) data system. These data represent the highest quality assured PM10 data. The data are amenable to further analysis and processing with common spreadsheet and database software. ARB's 2001California Almanac of Emissions and Air Quality is another useful source of data regarding annual average PM10 concentrations.

Strengths and Limitations of the Data

The indicator is simple, with readily available data, and easy to apply.

The limitations of this indicator include: the indicator does not allow computation of the number of monitors that were over the standard on a given exceedance day, does not provide information on population exposure, and is very sensitive to meteorological influences.

References:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

California Air Resources Board. The 2001 California Almanac of Emissions and Air Quality. Posted at: www.arb.ca.gov/aqd/almanac01/almanac01.htm

For more information, contact:

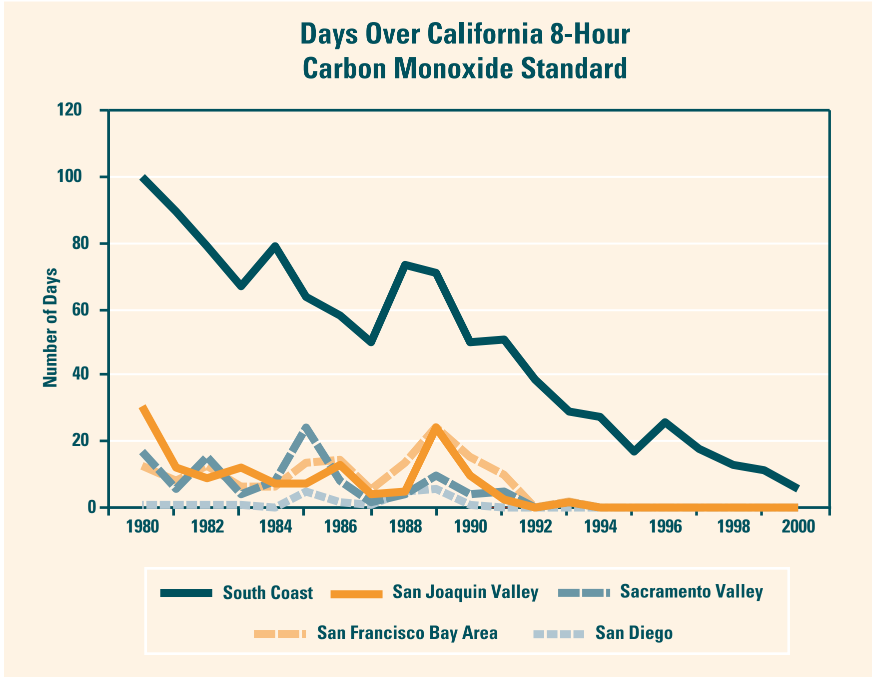
Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

Type I

Level 4
Goal 1

Days with Unhealthy Levels of Carbon Monoxide

Only the Los Angeles area and Calexico still exceed the state 8-hour carbon monoxide standard.



What is the indicator showing?

Days with unhealthy levels of carbon monoxide are decreasing throughout the state. The Los Angeles area was the only major urbanized area with any unhealthy days since the early 1990s.

Why is the indicator important?

Carbon monoxide is harmful because it is readily absorbed through the lungs to the blood, where it binds with hemoglobin and reduces the ability of blood to carry oxygen. As a result, insufficient oxygen reaches the heart, brain, and other tissues. The harm caused by carbon monoxide can be critical for people with heart disease, chronic lung disease, and for pregnant women. Exposure to high levels of carbon monoxide can result in headaches, dizziness, fatigue, slowed reflexes, and death.

Attainment of carbon monoxide standards requires that concentrations rarely exceed a prescribed level. For example, the level of California's 8-hour carbon monoxide standard is 9.0 ppm; when on average only one day per year is above this level (with few exceptions), the state standard will be attained.

The only region in California that is currently in non-attainment of the federal and state 8-hour carbon monoxide standards is the South Coast Air Basin and Calexico. The city of Calexico is in Imperial Valley just north of the Mexican border from Mexicali. It is suspected that the high carbon monoxide levels in Calexico are a cross-border pollution issue (further information on cross-border air quality issues can be found in the Transboundary Indicator section).

This indicator is selected to express the chronic nature of carbon monoxide exceedances in regions where standards are not yet attained. Other carbon monoxide indicators discussed below represent “worst-case” exposure.

What factors influence this indicator?

Carbon monoxide is a colorless and odorless gas that is directly emitted as a product of combustion. Incomplete combustion will result in increased carbon monoxide emissions. Motor vehicles generate over 85 percent of statewide carbon monoxide emissions. The highest concentrations are generally associated with cold, stagnant weather conditions that generally occur in the winter. In contrast to ozone, which tends to be a regional pollutant, carbon monoxide problems tend to be localized. Statewide, the number of days with unhealthy levels of carbon monoxide statewide decreased by 90 percent over the past two decades (from an average of 150 in 1981-83, to 15 in 1997-99).

Technical Considerations:

Data Characteristics

The number of days with unhealthy levels of carbon monoxide represents the chronic nature of 8-hour exposures in a region. This indicator can be used to approximate a region’s status with respect to an 8-hour carbon monoxide standard. It can also be used to construct trends that may respond differently over time compared to other carbon monoxide indicators. As emissions of carbon monoxide decrease, this indicator should respond with reduced counts of days with unhealthy carbon monoxide concentrations.

Data needed to determine the number of days with unhealthy levels of carbon monoxide are readily available from existing networks of air quality monitors in California. The data are maintained on the Aerometric Data Analysis and Management (ADAM) System and on the Federal Aerometric Information Retrieval System (AIRS) data system. These data represent the best quality-assured carbon monoxide data.

Strengths and Limitations of the Data

Although the indicator is simple, with readily available data, and easy to apply, it does not show the number of monitors that were over the standard on a given exceedance day. In addition, this indicator does not provide information on population exposure, and can be sensitive to meteorological influences.

References:

California Air Resources Board. The 2001 California Almanac of Emissions and Air Quality. Posted at: www.arb.ca.gov/aqd/almanac01/almanac01.htm

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/adq.htm

For more information, contact:

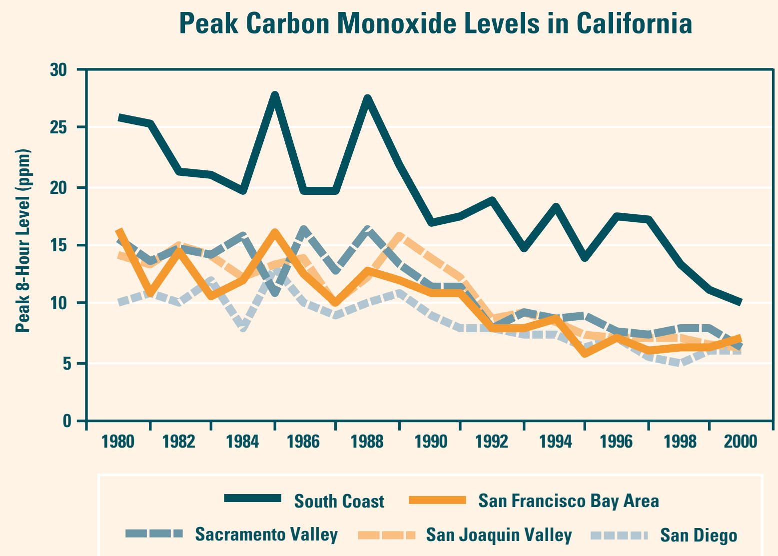
Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

Type I

Level 4
Goal 1

Peak 8-Hour Carbon Monoxide Concentration

Peak carbon monoxide levels have been declining.



What is the indicator showing?

Peak 8-hour carbon monoxide levels have declined and remained below the state 8-hour standard (9.0 ppm) since the mid-1990s in all but the South Coast air basin. However, the South Coast was near attainment in 2000.

Why is this indicator important?

Inhalation of high levels of carbon monoxide reduces the bloods' ability to carry oxygen and can lead to insufficient oxygen reaching the heart, brain, and other tissues. Carbon monoxide inhalation can also impede coordination, worsen cardiovascular conditions, and produce fatigue, headache, weakness, confusion, disorientation, nausea, and dizziness. Very high levels can cause death. Persons with heart disease are especially sensitive to carbon monoxide poisoning and may experience chest pain if they breathe the gas while exercising. Infants, elderly persons, and individuals with respiratory diseases are also particularly sensitive.

The peak 8-hour carbon monoxide concentration is related to the status of measured carbon monoxide data with respect to the state standard of 9.0 ppm, and represents the "worst-case" concentration over 8-hours during that year for a particular region.

What factors influence this indicator?

During the 1980s, carbon monoxide was a major air pollutant in California. With the introduction of more stringent automobile emission standards, only a few locations continue to violate the state 8-hour carbon monoxide standard. In the last twenty years, peak 8-hour carbon monoxide levels decreased in the South Coast almost 30 percent, from an average of 24 ppm in 1981-83, to 17 ppm in 1997-99.

Technical Considerations:

Data Characteristics

Data needed to determine the annual peak 8-hour carbon monoxide concentration are readily available from existing networks of air quality monitors in California. The data are maintained on the Aerometric Data Analysis and Management (ADAM) System and on the Federal Aerometric Information Retrieval System (AIRS) data system. These data represent the best quality-assured carbon monoxide data.

The peak 8-hour carbon monoxide concentration is supported by routine, extensive monitoring using accepted scientific instrumentation in regions where carbon monoxide standards may be exceeded. The indicator is a common method of summarizing carbon monoxide data in relation to carbon monoxide standards. Furthermore, this indicator is convenient to calculate and easy to explain to all audiences.

Strengths and Limitations of the Data

The strengths of the indicator include the ability to chart carbon monoxide air quality as it responds to emission reduction programs. The indicator is simple, with readily available data, and easy to apply.

On its own, the indicator does not show the number of monitors that were over the standard on a given exceedance day. In addition, this indicator does not provide information on population exposure, and it tends to be very sensitive to meteorological influences.

References:

California Air Resources Board. The 2001 California Almanac of Emissions and Air Quality. Posted at: www.arb.ca.gov/aqd/almanac01/almanac01.htm

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

For more information, contact:

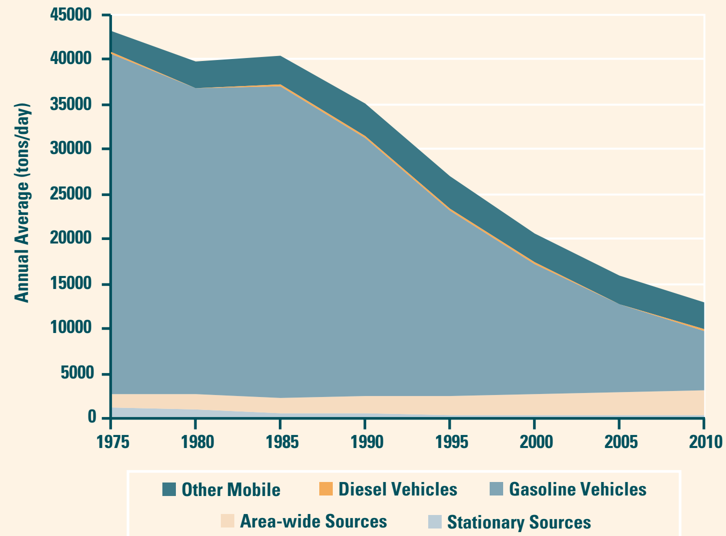
Joe Calavita
Planning and Technical Support Division
Air Resources Board
1001 I Street, Room 7-57F
Sacramento, California 95814
(916) 327-5783
jcalavit@arb.ca.gov

Type I

Level 3
Goal 1

Carbon Monoxide Emissions

Statewide emissions have been declining.



What is the indicator showing?

Total emissions of carbon monoxide have been declining over the last 25 years, primarily due to gasoline vehicle emission reductions.

Why is this indicator important?

Inhalation of high levels of carbon monoxide reduces the bloods' ability to carry oxygen and can lead to insufficient oxygen reaching the heart, brain, and other tissues. Carbon monoxide inhalation can also impede coordination, worsen cardiovascular conditions, and produce fatigue, headache, weakness, confusion, disorientation, nausea, and dizziness. Very high levels can cause death. Persons with heart disease are especially sensitive to carbon monoxide poisoning and may experience chest pain if they breathe the gas while exercising. Infants, elderly persons, and individuals with respiratory diseases are also particularly sensitive.

What factors influence this indicator?

Carbon monoxide is a colorless, odorless gas that is directly emitted as a product of combustion. The highest ambient concentrations are generally associated with cold stagnant weather conditions that occur during winter. In contrast to ozone, which tends to be a regional pollutant, carbon monoxide problems tend to be localized. Carbon monoxide emissions can be used in combination with air quality models to estimate regional and microscale impacts of emissions on neighborhoods. Carbon monoxide emissions originate predominantly from mobile sources, especially on-road gasoline vehicles.

Even though motor vehicle miles traveled (VMT) have continued to climb, the adoption of more stringent motor vehicle emissions standards has contributed to a 60 percent decline in statewide carbon monoxide emissions from on-road motor vehicles between 1975 and 2000 (see transportation background indicator for more information on VMT). With continued vehicle fleet turnover to cleaner vehicles and the incorporation of cleaner burning fuels, carbon monoxide emissions are forecasted to continue decreasing through the year 2010. Carbon monoxide emissions from other mobile sources are also projected to decrease through 2010 as more stringent emissions standards are implemented. Emissions from area-wide sources are expected to increase slightly due to increased waste burning and additional residential fuel combustion resulting from population growth.

Technical Considerations:

Data Characteristics

Air pollution control districts report emissions from stationary sources to the Air Resources Board on a yearly basis. Emissions from area-wide and natural sources are estimated using engineering methods on a rotating three-year basis. Carbon monoxide emissions from mobile sources are estimated with computer models yearly.

Emissions estimations are based on diverse sources of data, such as process rates for specific companies, emissions standards and vehicle miles traveled for cars, and number of heating degree days for a given year.

Strengths and Limitations of the Data

Although some air pollution control districts update their data yearly, others have not updated their emissions data for many years. Many area-wide source estimation methodologies are based on old data and are adjusted yearly with the use of surrogates. Because carbon monoxide emissions data are heavily dependent on methodologies and models that may or may not change from year to year, and because emissions are estimated on an annual basis, they are not sensitive to temporal changes of a year or less.

A major strength of this indicator is that it accurately reflect long-term changes in emission trends over a period of multiple years. Major improvements in estimation methodologies, or development of methodologies for previously uninventoried sources, may result in misleading changes in emission levels between years. To lessen this problem, emission trends are not measured – they are backcasted or forecasted based on growth and control data so that the inventory reflects consistent methodologies across the trend years.

References:

California Air Resources Board. The 2001 California Almanac of Emissions and Air Quality. Posted at: www.arb.ca.gov/aqd/almanac01/almanac01.htm

California Air Resources Board. Emission Inventory Procedural Manual, Volumes I-V, 1997.

ARB Emission Inventory Web Page, Posted at: www.arb.ca.gov/emisinv/eib.htm

For more information, contact:

Andy Alexis
Planning and Technical Support Division
Air Resources Board
1001 I Street
Sacramento, California 95812
(916) 323-1085
aalexis@arb.ca.gov

Type I

Level 2
Goal 1, 4

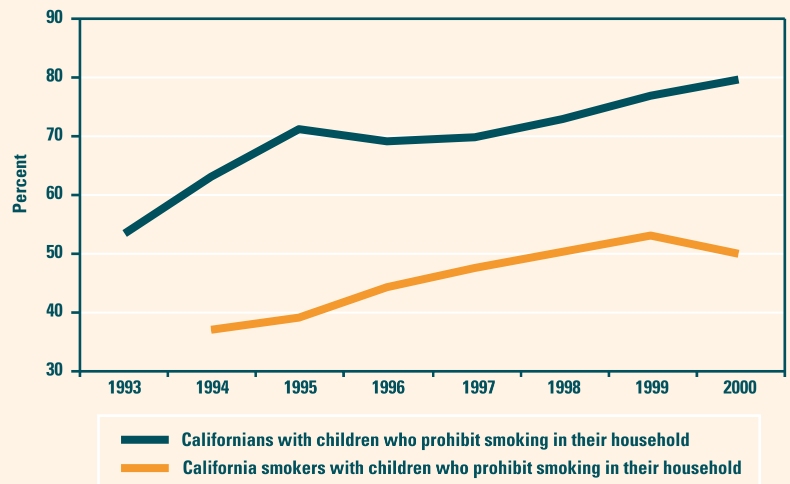
Household Exposure of Children to Environmental Tobacco Smoke (ETS)

There has been a steady increase in the number of households with children under 18 where smoking is prohibited.

What is this indicator showing?

Since 1993, yearly statewide surveys have shown a steady increase in the number of households with children where smoking is prohibited. In households with adult smokers, the percentage of homes with a smoking prohibition is lower than all households, but there is a principally increasing trend towards banning smoking in the home.

Households with Children Where Smoking is Prohibited 1993-2000



Why is this indicator important?

Environmental tobacco smoke (ETS), or second-hand smoke, is a major toxic indoor air contaminant and is of particular danger to the young. For infants and children, the single most important location for ETS exposure is the home. ETS exposure has been associated with lung cancer, childhood asthma and lower respiratory tract infections. Developmental effects associated with ETS exposure include low birth weight, sudden infant death syndrome, and an increased occurrence of childhood asthma (Cal/EPA, 1997). This indicator is based on a survey and provides only qualitative data. Therefore, the indicator is an approximation of infant and child exposure to ETS in the home.

What factors influenced this indicator?

In 1993, about one-half of all Californians with children under 18 prohibited smoking in the household. By 2000, nearly four out of five households with children under 18 had a prohibition on smoking. For households with children and adult smokers, about half prohibited smoking in their home in 2000, compared to about 37 percent in 1994. Due to Proposition 99, various tobacco-related health protection programs have been funded in the last 10 years, some of which specifically address childhood exposure to ETS in the home. These programs have been credited with increasing the recognition of the danger of household ETS exposure. Available data indicate that the prevalence of household ETS exposure in California is about 15 percent lower on average than elsewhere in the U.S., and is related to the lower percentage of adult smokers in California.

Technical Considerations:

Data Characteristics

Approximately 4000 California adults are surveyed annually to assess household smoking habits and rules. The survey is funded and collected by the Tobacco Control Section and the Cancer Surveillance Section, respectively, of the California Department of Health Services.

Strengths and Limitations of the Data

Annual surveys to assess smoking rules within households represent one of the easiest, most cost-efficient ways to quickly gather qualitative (“yes” or “no” type questions) information. While studies on the reliability of questionnaire responses indicate that they are generally trustworthy, use of quantitative data in conjunction with surveys shows that the surveys may underestimate the actual ETS exposure (Cal/EPA, 1997). The surveys are not intended to address questions regarding race/ethnicity, socio-economic status, and other variables.

While quantitative measures of ETS exposures are available, these are more expensive and labor intensive than collection of survey data, and have not been attempted on an ongoing basis. Such quantitative measures include the use of personal monitors and the measurement of ETS substances in saliva, urine and blood. The chemical cotinine, a breakdown product of nicotine, can be measured in bodily fluids and is an indicator of smoking and ETS exposure. However, the need for routine, ongoing biomonitoring of children for cotinine levels may be superfluous, given that the ETS survey is likely a sufficient indicator to reflect the trend in household ETS exposure. In addition, cotinine can be measured up to a day or two after exposure and may represent more of a measure of general exposure rather than household exposure.

References:

California Department of Health Services, California Adult Tobacco Survey (CATS), California Tobacco Control Update, Tobacco Control Section, Sacramento, California, 1993 to 2000.

California Department of Health Services, California Tobacco Control Update, Tobacco Control Section, Sacramento, California, August 2000, Posted at: www.dhs.ca.gov/tobacco

California Environmental Protection Agency. Health Effects of Exposure to Environmental Tobacco Smoke. Executive Summary, Office of Environmental Health Hazard Assessment. September 1997. Posted at: www.oehha.org/air/environmental_tobacco/finalets.html

For more information, contact:

Jon Lloyd
Department of Health Services
Tobacco Control Section
P.O. Box 942732, MS #555
Sacramento, CA 94234-7320
(916) 324-3921
jlloyd@dhs.ca.gov

Daryn Dodge
Office of Environmental Health Hazard Assessment
California Environmental Protection Agency
Sacramento, California
(916) 445-9375
ddodge@oehha.ca.gov

Type II

Total primary and precursor PM10 emissions

PM10 refers to particles with an aerodynamic diameter of 10 microns or smaller. Primary particles are emitted directly into the atmosphere while PM10 precursors are gases that are transformed into particles in the atmosphere. In addition to collecting data on PM10 levels, the Air Resources Board has recently begun a program for collecting data on PM2.5 levels statewide. Particles within the PM2.5 fraction of PM10 penetrate more deeply into the lungs, and is likely composed of a greater proportion of precursor gases than PM10. It is expected that data for indicators of PM2.5, similar to those presented for PM10, will be available within a few years. More information on the PM2.5 program can be found at: www.arb.ca.gov/aqd/pm25/pmfdsign.htm (PM2.5 Monitoring Network Design for California).

While methodologies exist for estimating primary PM10 emissions, there is a need for a better understanding of how precursor pollutants — such as reactive organic gases (ROG), ammonia, oxides of sulfur (SOx), and oxides of nitrogen (NOx) — contribute to the formation of inhalable particles. Work being done by the California Air Resources Board and other stakeholders will provide a better understanding of the composition of PM10 and PM2.5 and the relative contribution of precursor emissions to these pollutants. This information will help regulators determine the toxicity of PM10 and PM2.5 and pursue the most effective pollution control strategies. The PM precursor program is a priority for the Air Resources Board and the first data for this indicator is expected within five years.

References:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

California Air Resources Board. Emission Inventory Procedural Manual, Volumes I-V, 1997.

ARB Emission Inventory Web Page, Posted at: www.arb.ca.gov/emisinv/eib.htm

For more information, contact:

Andy Alexis
Planning and Technical Support Division
Air Resources Board
1001 I Street
Sacramento, California 95812
(916) 323-1085
aalexis@arb.ca.gov

Type II

Total emissions of toxic air contaminants (TACs)

TACs are emitted from numerous sources, including: stationary sources, such as electric power plants and refineries; area-wide sources, such as consumer products and architectural coatings; on-road motor vehicles, such as automobiles and trucks; and off-road motor vehicles such as trains, ships, aircraft and farm equipment.

The Air Resources Board periodically publishes inventories of criteria and toxic air pollutants from all categories of emission sources. ARB's most comprehensive TAC inventory — the California Toxics Inventory (CTI) — was last updated in 1996 and contains emissions for 33 toxic air pollutants in California's 58 counties.

The CTI is a snapshot of a variety of dynamic and variable processes. The stationary source data were developed from point sources reporting through the Air Toxic Hot Spots Program. The point source emission data represent the best available information for the source. However, the 1996 CTI emissions data may not have been specifically collected for that year. The ARB developed estimates for area sources and mobile sources using the 1996 criteria pollutant inventory and speciating total organic gas and particulate matter emissions into specific toxic pollutant emissions. The document "Basis for Determining 1996 Toxics Emissions, California Toxics Inventory" contains the procedures used by the ARB to develop the CTI.

The next update of the CTI inventory is expected by the end of 2001, thus allowing the development of a trend for TAC emissions in the state.

References:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

California Air Resources Board, Air Toxics Hot Spots (AB†2588) Program Web Site. Posted at: www.arb.ca.gov/ab2588/ab2588.htm

For more information, contact:

Linda Smith
Planning and Technical Support Division
Air Resources Board
1001 I Street
Sacramento, California 95812
(916) 322-6016
lsmith@arb.ca.gov

Community-based cancer risk from exposure to toxic air contaminants (TACs)

Type II

Eighty-eight percent of the cancer risk from TACs that have been quantified derives from three pollutants – diesel particulate matter (70 percent), benzene (10 percent), and 1,3-butadiene (8 percent). These three TACs derive primarily from mobile sources. Mobile, stationary, and area-wide TAC emissions can combine to pose potential cancer and noncancer health risks, particularly in urbanized areas.

This indicator will utilize data collected from air monitors and dispersion modeling to estimate ambient concentrations of air toxics throughout California. These estimated concentrations will be used to calculate excess cancer risk for each toxic air contaminant, and a cumulative risk will be calculated by adding estimated risk values for the toxic air contaminants in an air basin and/or a community. The results will be overlaid by demographic data using a GIS-based program. Additional demographic data, such as average income or ethnic background can also be utilized to address environmental justice issues. The GIS capability and tracking for assessing environmental justice-related issues are under development.

The ARB has monitored the TACs of greatest concern since 1990 at about 20 air monitoring sites located primarily in urban areas of the state. Ten years of TAC air concentrations are posted at the ARB website (www.arb.ca.gov/aqd/aqd.htm), along with the estimated cancer risk. The latter is expressed as the number of potential excess cancer cases per million people exposed over a lifetime (70-year) to the annual average concentration. Over the past 10 years, about a 50 percent decrease in the estimated cancer risk is seen at almost every monitoring site. However, the cancer risk values should not be regarded as absolute predictors of the actual risks faced by Californians, but rather as useful in representing the relative risk among the various TACs and to provide a general indication of trends.

Again, caution should be used in interpreting the cancer risk values literally as expected excess cancer cases per million people. Given that cancer risk assessments are intended to guide the development of regulatory standards to protect against the adverse effects of a chemical, a number of health-protective assumptions are used in the process of calculating the cancer risk values. For example, the vast majority of Californians are exposed only to minute amounts of these TACs (typically in the parts per billion range). The health-protective assumption is made that there is some risk to any exposure, no matter how small. In addition, it is known that there is variability and uncertainty among the human population with regard to the potential to develop cancer during a lifetime exposure to a cancer-causing TAC.

Thus, a scientifically accepted statistical method is applied to the data on a TAC's cancer potency to determine the 95 percent upper confidence limit of the slope of the dose-response curve. This allows for the uncertainties in our ability to predict the sensitivity of an individual to a cancer-causing chemical, and we believe that a level calculated in this way would protect the great majority of the human population adequately. Although it is theoretically possible that a given cancer risk prediction for a TAC is either an over- or under-estimate, the calculation is designed to produce a result which is probably an over-estimate, in order to be sure of protecting public health.

With this in mind, the TAC monitoring data and associated health risks for California air basins and counties can be viewed at: www.arb.ca.gov/aqd/almanac01/chap601.htm

References:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

For more information, contact:

Linda Smith
Planning and Technical Support Division
Air Resources Board
1001 I Street
Sacramento, California 95812
(916) 322-6016
lsmith@arb.ca.gov

Caroline Suer
Stationary Source Division
1001 I Street
Sacramento, California 95812
(916) 327-5985
csuer@arb.ca.gov

Type II

Cumulative exposure to toxic air contaminants (TACs) that may pose chronic and acute health risks

TACs can be emitted by stationary sources, area-wide sources, and mobile sources. Some of the most prevalent TACs include diesel particulate matter, benzene, and formaldehyde. TACs present both potential cancer and noncancer health risks, particularly in heavily urbanized regions.

Noncancer (chronic and acute) health endpoints are assumed to have a threshold for effect. If the exposure is below the individual's threshold for effect, then no adverse effect would be expected. However, simultaneous exposure to two similar chemicals at sub-threshold levels may result in a toxic response. The combined impact of several chemicals present at the same time are assessed assuming the interaction of the chemicals will be additive for a given toxicological endpoint (such as eye or throat irritation), unless information is available to the contrary.

This indicator would utilize air monitoring data and dispersion modeling to estimate ambient concentrations of air toxics throughout California. Particular attention will be paid to the main air basins known to have the highest air levels of TACs in California (South Coast, San Diego, San Joaquin Valley, San Francisco Bay Area, and Sacramento Valley). Currently, the data on long-term ambient air concentrations of TACs are being compiled and will be presented in a future indicator for chronic noncancer risk. Collection of acute TAC exposure data is more resource intensive since it requires hourly ambient concentration data. The acute noncancer risks posed by TACs may be presented in a future indicator, as more complete data on hourly levels of TACs is collected.

Reference:

California Air Resources Board. ADAM Air Quality Database. Posted at: www.arb.ca.gov/aqd/aqd.htm

For more information, contact:

Linda Smith
Planning and Technical Support Division
Air Resources Board
1001 I Street
Sacramento, California 95812
(916) 322-6016
lsmith@arb.ca.gov

Caroline Suer
Stationary Source Division
1001 I Street
Sacramento, California 95812
(916) 327-5985
csuer@arb.ca.gov

Visibility on an average summer and winter day and in California national parks and wilderness areas

Type II

One of the most intuitive methods used by the public to assess air quality is to visually assess the distance one can see. More exact measures of visibility and visibility trends, however, are more difficult to come by. Visibility records, developed using a variety of measurements, are available for a small number of sites in California. However there is no statewide database from which to assess visibility trends, and development of such data is extremely resource intensive. Visibility can also be measured indirectly by “reconstructing” visibility based on the light extinction characteristics of the particles in air. “Speciated” particulate monitors provide data about the chemical composition of ambient particles that can be used to reconstruct visibility. A monitoring network that speciates fine particulates in California is gearing up and is expected to provide detailed data within the next few years.

Since particulate matter (PM) composition and spatial distribution vary seasonally, visibility should be reported separately for summer and winter. For trend tracking purposes, reporting visibility as average summer and average winter visual ranges will provide a measure of progress on improving visibility in California.

In 1999, the U.S. EPA promulgated a regional haze regulation that calls for states to establish goals and emission reduction strategies for improving visibility in 156 Class 1 Areas (national parks and wilderness areas), 29 of which are in California (including Yosemite, Redwood, and Joshua Tree National Parks). Currently, there are 17 monitors deployed in California’s Class I areas to specifically evaluate visibility trends. As reconstructed visibility data from those sites becomes available, we will incorporate this data into our assessment.

For more information, contact:

Tony Van Curen
Research Division
Air Resources Board
1001 I Street
Sacramento, California 95812
(916) 327-1511
rvancure@arb.ca.gov

Type III

Indoor exposure to formaldehyde

Studies of human exposure to air pollutants indicate that indoor levels of many air pollutants may be two to five times (and occasionally more than 100 times) higher than outdoor levels. This is of special concern since people spend, on average, 90 percent of their time indoors.

Formaldehyde is a pollutant of concern for indoor air. Formaldehyde levels have been found at concentrations that are many times higher than outdoor concentrations. Formaldehyde exposure can cause eye, nose, and throat irritation, wheezing and coughing, fatigue, skin rash, and cancer. Indoor sources of formaldehyde include pressed wood products (for example, hardwood plywood, particleboard, and medium density fiberboard), furniture made with these pressed wood products, combustion (e.g., wood burning and cigarette smoke), durable press drapes, other textiles, glues, cosmetics, and many other products. Formaldehyde exposures in homes and other indoor environments can be reduced by a variety of source control measures such as using improved or substituted products that contain little or no formaldehyde, source removal or avoidance, source barriers, and climate control.

Monitoring data for formaldehyde (or any other pollutant) within homes, schools or public buildings are scarce. The ubiquitous nature of formaldehyde sources, their proximity to people, and the reduced ventilation in some indoor environments, however, suggest that the potential for unhealthy exposures is high. An indoor air indicator for this pollutant would help determine the extent of the problem and the effectiveness of any actions taken to reduce levels of this hazardous gas in indoor air.

For more information, contact:

Peggy Jenkins
Research Division
Air Resources Board
P.O. Box 2815
1001 I Street
Sacramento, California 95812
(916) 323-1504
mjenkins@arb.ca.gov